OVER-OCEAN CARGO FORECASTING

DRC Inventory Research Office
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November 1976

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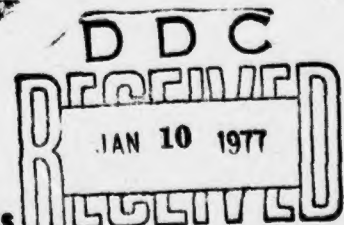# OVER-OCEAN CARGO FORECASTING

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OVER-OCEAN CARGO FORECASTING

FINAL REPORT

BY

ROBERT L. DEEMER

DONALD A. ORR

NOVEMBER 1976

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DRC INVENTORY RESEARCH OFFICE
US ARMY LOGISTICS MANAGEMENT CENTER
ROOM 800   US CUSTOM HOUSE
2ND AND CHESTNUT STREETS
PHILADELPHIA, PA. 19106

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)
Cargo Forecasts
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)
Presently there is no standard method of forecasting over-ocean cargo requirements within the Army. An operational analysis identified the important elements of the forecast. The agencies most suited to do the various aspects of the forecast and the data they could best be using to make the forecast are proposed.

The forecasts are broken down into major, special and residue cargo forecasts and the latest information is combined with past history by use of the Kalman forecasting algorithm developed in previous IRO work.

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Block 20 (Abstract Continued)

The proposed forecast makes use of the Logistics Control Activity (LCA)
feedback system already in question; a monitor at the LCA is recommended
who can override the computer generated forecasts when appropriate.

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SUMMARY

1. Background

In September 1975 representatives from the US Army Materiel Development
and Readiness Command (DARCOM) and the US Army Automated Logistics Manage-
ment Systems Agency (ALMSA) assigned the project of improving the over-ocean
cargo forecasting to the DARCOM Inventory Research Office.

The over-ocean cargo forecast covers a wide area. Forecasts are
necessary for sea transportation for the Military Sealift Command (MSC)
and air transportation, Military Airlift Command (MAC). The Transportation
Services, MSC/MAC, require the forecast to be by program - troop support
or international logistics (both aid and sales). MSC further requires two
other breakdowns, viz, commodity and type of package. The commodities
are general cargo, special which is outsized or heavy weight cargo, reefer
which requires chilled or frozen cargo compartments, ammunition and
assembled aircraft. The air cargo only goes as one classification, general.
The type package classification is break bulk, commercial container, and
military container.

Since there are approximately 4 origins and 50 destinations for sea
channels, 6 origins and 75 destinations for air channels, three programs,
four commodities for sea, one for air and three types of packages for sea,
quite a few forecasts must be made (approximately (4x50x4x3) 2400 for
sea and (6x75x3) 1350 for air).

The procedure for over-ocean cargo forecasting at the present time
is for each National Inventory Control Point (NICP) to predict its own
requirements for over-ocean transportation. There is no definitive
guidance on how the NICPs are to accomplish this requirement; hence,
each NICP does their forecast in a different manner.

Most of the NICPs have the Requirements Division of the Material
Management Directorate initiate the forecast which is then sent to the
Transportation Division of the same Directorate for consolidation and
updating. The requirements are obtained in different ways, however.
For example, one NICP uses a quarterly report specifying requirements in

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dollars. These dollars are then transformed to tons via a multiplier developed for such usage. Another NICP uses the expected depot workload as a basis for the forecast for over-ocean cargo. They identify the portions to go via sea and air by applying a percentage factor. One NICP has the Transportation Division do the whole forecast; gather data for expected requirements, make projections, consolidate requirements and make any changes due to recent buildup/reduction programs.

All forecasts presently go to the Logistics Control Agency (LCA) where the NICP's forecasts are consolidated and finalized.

The forecasts are submitted for two periods of time. The long range forecasts cover a year and based on this forecast, MSC and MAC set up transportation costs for the year. The short range forecast covers 90 days (broken down into 30 day intervals) and is used by MSC/MAC to schedule their ships to the origins and destinations. The Transportation Services work on a smaller time interval, day to day or week to week, rather than monthly for which present Army forecasts are made.

The long range covers the same period of time as that needed by the Transportation Services and schedules are not actually applied to this forecast. The long range forecast is an estimate of expenditures for the coming year.

Prior to the start of this particular project the LCA was working on a forecast feedback system to the NICPs. Up to this time the NICPs were working without information as to how good or bad their forecasts were. The LCA feedback system (LCA-FB) is an attempt to help the NICPs do a better forecasting job. Previous work [6] on the over-ocean cargo forecasting problem related any progress in the forecasting with the development of the LCA-FB. The current work synthesizes the LCA-FB with a general forecast system.

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2. Purpose and Objectives

The purpose of this work is to develop a forecasting methodology of DARCOM sponsored over-ocean cargo movements.

The first objective is to determine what impact the DARCOM sponsored forecast has on the overall channel forecasts. Other objectives of the study are to see what Army agency should be responsible for making the over-ocean forecast, the data which the agency should be using to make the forecast and the methodology of the forecast. Another objective is to automate the forecasting procedure wherever possible.

3. Scope and Method

The scope of this study is limited to improving DARCOM sponsored outbound (traffic moving from continental U.S.) over-ocean cargo forecasts. The forecasts cover the Army managed, as well as DSA/GSA managed items, for which the Army is responsible upon receipt at the shipping terminals in continental U.S. The forecast does not include forecasts of petroleum, oil, and lubricants, privately owned vehicles, or household goods. The analysis does cover both short and long range forecasts.

The objectives of this study are satisfied mostly by doing operational analysis. The analysis reveals the interface between the various agencies and divisions and branches within a given agency. Analysis of available data is also accomplished. Some mathematical forecasting schemes are developed based on previous IRO work.

4. Conclusions and Findings

Operational analysis of the various organizations generating and utilizing the over-ocean cargo forecasts has indicated reasonable alternatives for the structure of a forecast system and has provided the basis for selecting one of the alternatives. Previous IRO experience in forecasting techniques has provided the specific methodology for generating forecasts within the basic structure.

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The proposed structure:

    a. Cargo movement of major items is forecasted by the major subordinate commands.

    b. Forecasts of secondary item movement are computer generated at the Logistics Control Activity. Also automatic adjustments at LCA are made to the subordinate command forecasts.

    c. A human monitor at LCA provides manual intervention to automatic forecasts.

The proposed methodology:

    d. The Major Item Distribution Plan and the International Logistics Supply Delivery Plan are the basic source documents for the monthly major item forecasts.

    e. Lift arrays are stored and updated in LCA computers to provide historical averages of tons lifted over individual air and sea channels.

    f. A Kalman filter algorithm (akin to exponential smoothing with a variable weighting factor) is the basic updating mechanism at LCA.

    g. The current LCA - Feedback reporting system with some modifications provides the mechanism for breaking out the total monthly lift by the required categories.

Post analysis of actual and forecasted movement under the proposed system will provide data to improve forecast parameters and focus the monitor's activities. Caution should be exercised in expending time and resources for increasing system sophistication (e.g. complete automation of submitted forecasts) because the ultimate use and impact of the monthly forecasts in the daily lift operations does not warrant such expenditures.

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CHAPTER I
TRANSPORTATION OPERATIONS

1.1 Surface Lift Activities

One can best be oriented in the operation of these activities using
quoted sections from DoDR 4500.32-R Milstamp [4]. Refer to Appendix A
for this description. In the present section, special facts, uncovered
in our investigations, are presented that had direct and indirect in-
fluences of various degrees on the proposed forecast system.

a. MSC uses the forecast to direct ships under their control to
general areas of origin (East, Gulf, California, Northwest coasts).
Planning starts around 45 days before the operating month (OM). MTMC
(via the WTCA's) gives notice (10-30 days before OM) as to which specific
ports to visit, based on ETR's. MTMC allocates cargo to as few ports
as possible to make up a full shipload (since it takes about a week to
load and leave one port). MSC rarely re-deploys ships to other areas
based on MTMC visibility on actual cargo generation during the month.
There are about 8 MSC ships on scheduled runs from East Coast; of these
3 are coal ships and one ship handles most of the POV's (privately owned
vehicles) for all services. There are 3-4 control ships on schedule from
the Pacific coast. Ammo and assembled aircraft are carried by MSC con-
trolled ships.

b. MSC uses the forecast to book space on commercial ships. About
two-thirds of general cargo is containerized and goes commercial.

c. Constraints on the schedule of commercial ships, types of cargo,
deadlines, and potential return cargo makes allocation, scheduling, and
booking of ships much of an art.

d. Nature of forecasts submitted to MSC is such that total tonnages
are not bad but breakouts by channel are. The projected commodity mix
is poor and the projected use of individual channels changes, particularly
on international logistics shipments. MSC uses its own aggregate histori-
cal factors to adjust for commodity mixes, peak months, and sometimes bias,
but there is no specific procedure for manipulating individual channel

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forecasts. Currently the Army is around 50% of the total MSC commitment.

e. Shipping status data from depots is available 7-14 days prior to moving materiel to port. The average turn-around time for a water terminal to notify a depot that a ship is available is 14-21 days.

f. MSC receives May-June-July forecasts around April 10. MSC planning document (allocation of control ships and projections of tonnages) is sent to terminals around April 20.

We see from these facts that MSC uses the 3 month forecasts for general control of ships, but that MTMC and the water terminals use shipping status data on potential cargo generation, which often can be received before the last MSC projections for a month to direct pick-ups on a weekly basis. We begin to perceive that the monthly forecasts from the Army Logistics Control Activity should not be costly or sophisticated, but utilize reasonable historical factors to obtain commodity mixes, etc. and be adjusted with the latest "inside" information.

1.2 Air Lift Activities

The Military Airlift Command (MAC) has the responsibility of moving the Army (as well as the other Services) cargo from continental U.S. to overseas locations via air shipments. Unlike MSC, MAC flies cargo from many bases within continental U.S. (CONUS) to many bases overseas. The over-ocean shipments act as training for the crews as well as actually transporting cargo since so many flying hours are required by the crews to remain qualified. The majority of air shipments for DARCOM sponsored materiel are by MAC rather than commercial lines, hence crews as well as planes must be scheduled to meet the criteria of necessary flying hours.

MAC receives the long range forecast from the various users and from this projects the number of planes and flights needed. These determine the rates for the various routes. Therefore, the more accurate the long range forecast the more consistent the rates will be to the actual costs. Under forecasting means more flights will be needed than were expected and the Army will be paying more than their original budget requirements. If the forecasts are more than what actually is needed, fewer flights

are required and the Services actually will be paying less than expected.
This means MAC is caught with a shortage and therefore next year they
will have to charge more to make up the loss incurred this year. Thus,
more accurate forecasts benefit everyone.

MAC receives the short range forecast 80 days before the operating
month, i.e., the month which is forecasted. Nothing is really done with
this forecast by MAC for several weeks. During this time the Army can
update forecasts with more recent knowledge. About 30 days before the
operating month MAC publishes a schedule of flights for the operating
month. Changes to the schedule can be made up to and into the operating
month. This forecast enables MAC to get the planes and crews to the
right base for the flights. Changes to the schedule may mean empty
planes flying from one base to another.

An important aspect of the MAC operation is that even with "perfect"
monthly information from the Services, they could still have scheduling
problems since they operate on a day-to-day basis. Thus, if all the cargo
materialized on the first of the month MAC could be caught holding cargo
for the entire month. Or conversely, if all the cargo became available
at the end of the month, there could be quite a few empty flights or a
problem getting the necessary flight time for crews earlier in a month.

All of the above considerations indicate an accurate long range
forecast is desirable but the short range forecast need not, and cannot
under present data restrictions, be all that precise. Thus, a simple
and inexpensive forecast should be obtained for MAC cargo movements.

1.3 DARCOM Depot Activities

The DARCOM depots are the storage locations of the National Inven-
tory Control Points'(NICP) stocks. The depots receive the materiel re-
lease order (MRO) from the NICP with specifications as to where the cargo
is to go and when it is to arrive. The required delivery data (RDD) is
usually only applicable to international logistics. The depot gathers
items together into a truck load. When they have sufficient materiel
for a truckload the depot notifies the appropriate MTMC or air base that

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the cargo is available. MTMC in return notifies the depot when a ship
is expected which could be used to ship the cargo. Likewise the air cargo
is sent when a plane is available. The trucks are loaded and dispatched
only when the depot receives word of transportation availability. The
depots wait a week on the average before being notified of available
ships, but they can wait as long as 30 days. Only upon this notification
are the trucks actually loaded and dispatched to the terminals.

The depots do not see any kind of cargo forecast or schedule of
ships or planes for any period of time. They do not become involved in
any way with either the NICP forecasts or MSC/MAC schedules. They simply
gather cargo for shipments when the MRO is received and ship to the
terminals when a carrier is available.

CHAPTER II

FORECAST OVERVIEW

2.1 General

The proposed forecast procedure is divided into an external major item forecast and a remainder (mostly secondary items) forecasted internally by LCA. The remainder forecast is further broken out by a special and a residue forecast. The external forecast will make use of bridging arrays (see Section 4.3.1) and both the external and internal forecast will use lift arrays (see Section 2.4) to combine previous forecasts with the new forecast.

The external forecasts will be made at the NICP's and United States Army International Logistics Command (USAILCOM). These forecasts will then be forwarded to LCA where they will be combined with the LCA internal forecasts. The forecasts for the different areas/commodities/etc. are then to be sent to MSC/MAC. In return MSC/MAC will send notification to LCA on what was lifted as well as when and where it went. LCA will develop the feedback system report based on the lift data and send out the feedback report to the external forecasters. The lift data will be used to automatically update the internal forecasts.

This is an overall view of the proposed forecasting procedure. The following sections and chapters will develop how this is done.

2.2 Types of Forecasts

A 1970 Institute for Defense Analysis (IDA) report [7] has the following breakdown of data on tons sent to Vietnam, not including Army Aviation items or repair parts:

Class VII	(major end items)	352,598 tons
Class IX	(repair parts)	225,760 tons

Field Manual 38-24 [5] shows that the Army manages 100% of the Class VII items and 38% of the Class IX items. Hence the Army is responsible for approximately:

Class VII	352,598 tons
Class IX	85,789 tons

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These figures show major items amount to 80.4% of the tons sent
to Vietnam in 1969 and repair parts for 19.6%. These figures are not
altogether accurate since there is a total of 10 classes of items. The
Army has no responsibility for five categories which are:

Class I   (subsistence)
Class III   (petroleum, oils, and lubricants)
Class VI   (personal, non-military items)
Class VIII   (medical materiel)
Class X   (materiel to support non-military programs)

There are a total of five classes in which the Army does have some
management responsibility. They are:

Class II   (clothing, individual equipment, tool kits)
Class IV   (construction)
Class V   (ammunition)
Class VII   (major end items)
Class IX   (repair parts)

Two of these classes are accounted for above. Ammunition is fore-
cast specially and was considered separately in the IDA report. This
leaves Class II and Class IV as yet unaccounted for in the above figure.
Of these categories the Army manages 11% of the Class II items and .2%
of the Class IV items. IDA report shows 55,509 tons for Class II items
can be extracted and included in the Army repair parts figures. Calling
this class now secondary items the figures are:

Class VII (major item)   352,598 tons (71.4%)
Class II and Class IX (secondary items)   141,298 tons (28.6%)

The IDA report did not include any Class IV figures. However, if
a small percent of total tons is applied to Class IV for this period -
those were declining years in terms of activity - an approximate percent
of major items tons is 70%.

Telephone conversations with people responsible for the DARCOM

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forecast at LCA produced the following monthly average of tonnage over a three month period in early 1976:

Service	Sea	M-Tons	%	Air	S-Tons	%
Army		33,035	17.7		687	77.4
DSA/GSA		153,147	82.3		201	22.6
Total		186,182			888	

These figures are based on forecasts LCA presently sends MSC/MAC. They show that DSA/GSA requirements are quite significant for sea transportation. Therefore, any accuracy in the Army forecast would be greatly diluted in the overall forecast if the DSA/GSA portion was not very good.

Dilution of the impact of Army forecast also occurs because of the nature of the Transportation Service needs. That is, MSC/MAC work on a day-to-day basis for scheduling ships, planes and crews and the very best the Army can do is a monthly forecast. Also, for the most part, all the Service requirements are combined.

From these two sets of figures (major versus secondary and Army versus DSA/GSA) it is observed that a definite breakout of these two factors is quite desirable. The Army presently has very little data to forecast DSA/GSA requirements; however, the best DSA/GSA forecast possible should be made since it is such an influential factor in the overall forecast.

Another breakout for sea transportation is special type of items – reefer chill (refrigeration required), reefer freeze (freezer required), special (commodity weight over 10,000 pounds or measures more than 35 feet in any dimension) and general items. The breakdown into these types of commodities is not based on any statistics but since special ships are required for the first three categories, the forecasts should be broken out by these stratifications. Air cargo would not have this breakout since all cargo is general air freight and there are no special shipments made (in the above context).

There are three intrinsic breakouts:

1. Major items
2. Special items (mostly GSA/DSA)
3. Remainder (mostly secondary)

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Major items can further be broken out by troop support (TSP) re-
quirements (requirements for the US Army) and International Logistics
(IL) requirements (requirements for foreign countries). TSP require-
ments are managed by the Commodity Commands (there are six Commodity
Commands which will be referred to as XCOMs). Although the XCOMs manage
the items which are used in IL, the US Army International Logistics Command,
USAILCOM, has final responsibility for items going to foreign countries and
also receives lift data directly from the Transportation Services.

The item managers at the XCOMs have the latest and most accurate
information on the major items and should, therefore, do the major item
forecast. The Major Item Distribution Plan (MIDP) is the document upon
which the basic major item deployment schedules are based. Hence, the MIDP
is the basic document to use to build a forecast. Since all the forecasts
will have to go to LCA, the XCOM's forecast will be referred to as the
external forecast, i.e., external to LCA.

The MIDP does not include major items for use in IL. USAILCOM has
its own document, the International Logistics Supply Delivery Plan (ILSDP).
This is similar to the MIDP and should be used by USAILCOM for the IL
external forecast. Any other forecasts, generated or derived at LCA are
called internal forecasts, i.e., internal to LCA.

2.3 Flow of Information

Figure 1 is a schematic of the proposed information flow of the total
over-ocean cargo transportation system. The XCOMs and USAILCOM will provide
LCA with their forecasts, Army TSP and IL requirements respectively.

The LCA will receive lift data from the Transportation Services -
MTMC, MSC, MAC - in the form of the Transportation Control Movement
Document (TCMD). This information will go into the LCA-FB system. The
XCOMs will receive a copy of the LCA-FB report and this will enable them
to see how accurate their basic forecasts are. USAILCOM will receive the
TCMD cards directly for IL items. The output of the LCA-FB system is
also the input to the updating of the lift array. The lift array will
be expanded fully in the next section.

The updated lift array and the newly computed XCOM/USAILCOM forecasts

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FIGURE 1
INFORMATION FLOW

FIGURE 1
INFORMATION FLOW

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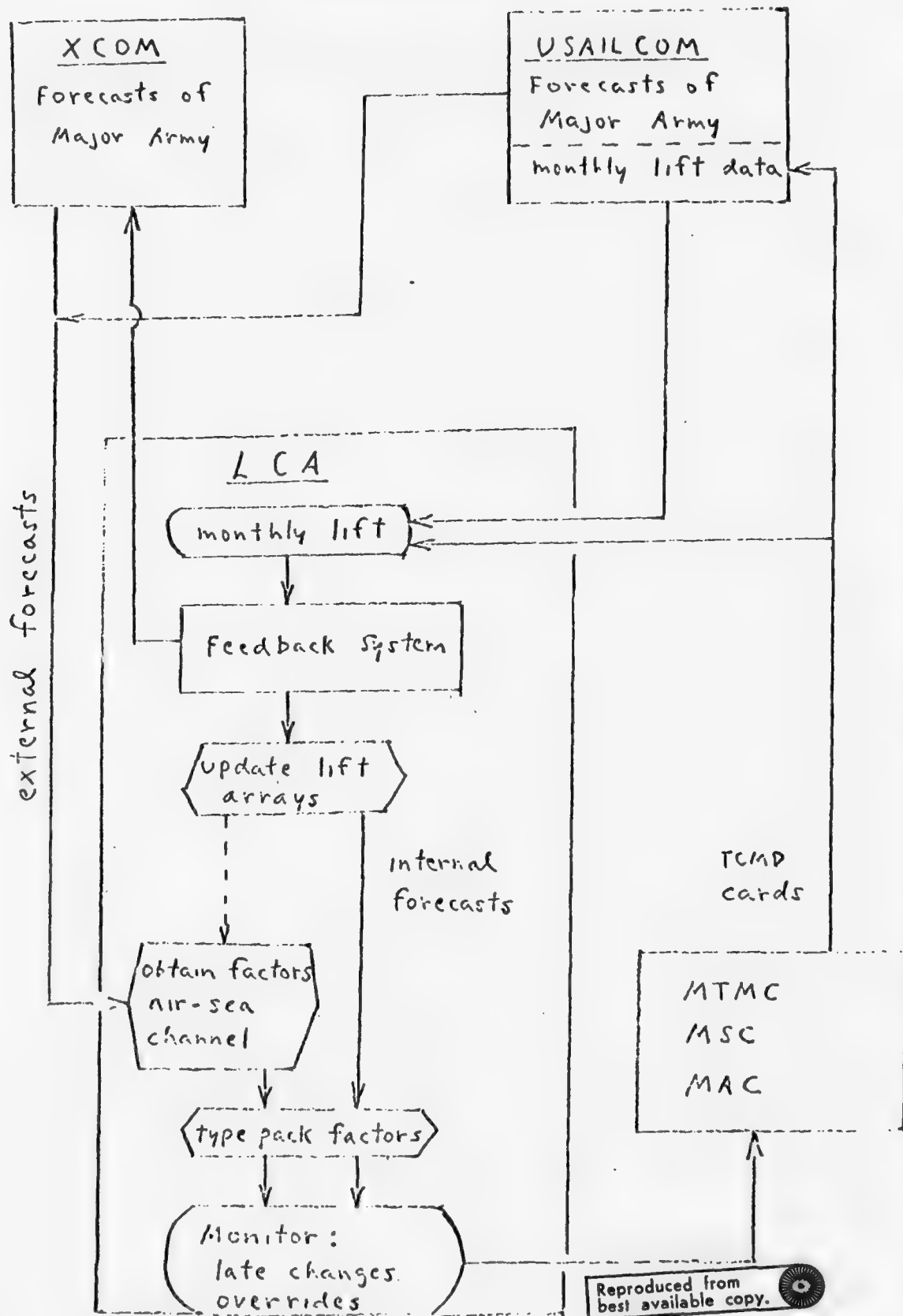
are then input to the forecast routine which computes the forecast for channel/mode/commodity/type of package. This routine makes use of a bridging table (see Section 4.3.1) to prorate external forecasts submitted for general areas to individual sea and air channels.

This updated forecast is then reviewed by the monitor at LCA (see Section 6 this chapter and Section 5 Chapter IV) for reasonableness and to change forecasts if updated troop movements or revised production/ maintenance schedules necessitate changes.

After acceptance by the monitor at LCA the forecasts go to the respective Transportation Services for implementation by them.

This information flow would occur every month except for the external forecasts which would be updated semi-annually for the XCOM forecasts and quarterly for USAILCOM forecasts. The total computation would only be accomplished at these intervals since that is the frequency of the basic document updates, MIDP and ILSDP (see nex chapter for details). In the interim, any XCOM knowledge of activities which would affect cargo movements should be incorporated into an update of the original forecast.

2.4 Lift Arrays

Figure 2 shows the attributes of the lift array. The first column, code, will be referred to throughout this report and defines the various categories of forecasts. There are eight categories of forecasts:

a. Sea - Major TSP

b. Sea - Major IL

c. Sea - Special TSP and IL

d. Sea - Residue TSP and IL

The remaining four are the same as above except for air instead of sea.

The Sea Transportation mode uses four general area origins: East Coast, Gulf Coast, California, and Northwest. There are presently 48 over-ocean sea destination. The N_o and N_D destinations of the Air mode is meant to signify there are a number of origins and destinations; which change frequently. Deletions and additions to air origins and destinations occur several times a year. Addition does not always mean a deletion.

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FIGURE 2

LIFT ARRAYS

	DESCRIPTOR				SIZING			ELEMENTS		
CODE	MODE	ITEM TYPE	PROGRAM	ORIGIN	DESTINATION	COMMODITY		AVG LIFT	WGT FACTOR	FACTOR
1	SEA	MAJOR ARMY	TSP	4	48	4		L	WGT	K
2		MAJOR ARMY	IL	"	"	4				
3		SPECIAL DSA, GSA	TSP,IL	"	"	3				
4		RESIDUE	TSP,IL	"	"	1				
1A	AIR	MAJOR ARMY	TSP	N_O	N_D	1				
2A		MAJOR ARMY	IL	"	"	1				
3A		SPECIAL DSA, GSA	TSP,IL	"	"	1				
4A		RESIDUE	TSP,IL	"	"	1				

There are four different commodity cargos available for sea lift: reefer chill, reefer freeze, special, and general. The special forecast (code 3) has only three cargos since general is not a special type of cargo. The air mode does not have any breakout of commodity except general air cargo.

The lift array is the basic building block for the over-ocean forecast. It is an array which is stored in the LCA computer which keeps the last forecast (L), the weighting factor (WGT) and the K-parameter for every possible channel, appropriate commodity, program and mode for which forecasts could be made.

The three elements: Average Lift, Weighting Factor and K-Factor are elements of the forecast, all of which have to be stored since they are necessary to make the next forecast. The Average Lift is the last forecast and the other two elements are factors used to get the new forecast (see Chapter IV for methodology).

Information of the actual lift data is sent to LCA from the Transportation Services. This data is gathered together for one month and then the elements L, WGT, K for each channel, commodity, program and mode are updated.

The LCA internal forecasts (both special and residue) are the results of using the latest lift history combined with the previous forecast in the forecast algorithm. These internal forecasts are not related to activity except in an historical sense. This is the reason the XCOM transportation and the LCA monitor are such vital components in the forecasting system.

On the other hand, the external forecasts are updated from the external sources semi-annually (XCOM) and quarterly (USAILCOM). However, the lift array will have to be maintained for these forecasts since the updates require these values and, in addition, monthly forecasts are needed. The MIDP covering the whole year has requirements by month; however, the half-year MIDP has the next year requirements by quarter. Thus, the MIDP which starts covering requirements in the middle of the year may necessitate approximations of monthly requirements at the beginning of the next year.

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2.5 Feedback System

From the schematic in Figure 3 and the summary table of arrays, there are 8 categories for which forecasts are made. In every category the forecasts depend upon monthly lift in that category for updating. Total tonnage moved in a month is available from the weights and cubes reported on the TCMD cards covering that month, which are sent by the lift commands. The LCA feedback system with some logical modifications (see Appendix B for details) is capable of subtracting out and assigning the movement for:

        a. Major Army Troop Support - Sea and 1a - Air

        b. Major Army International Logistics - Sea and 2A - Air

        c. Special DSA/GSA - Sea and 3A - Air

The remaining TCMD cards are used directly to obtain cumulative weight and cubes which are assigned to movement for 4 and 4A. This last procedure is not only simple but it acts as a compensator for the whole forecast system. For example, if some tons for major items are missed in the matching process on requisitions, the major item forecasts may be low; however, the residue tons will now be larger and the resulting over fore- casts will compensate for the under forecasts in the overall submissions to MSC and MAC.

2.6 The Monitor

The forecast system has three pillars: the external forecasts, the updating of lift arrays and a monitor. A knowledgeable monitor is required to manually override the computer outputs or to change stored parameters when late breaking information has impact. He is responsible for the final massaged, merged, formatted forecasts submitted monthly to MSC and MAC. Details on his duties are found in Section 4.5.

2.7 Timing

There are two over-ocean cargo forecasts - long range and short range. The long range covers a year in time and is used to set rates for cargo transportation by MSC/MAC and for allocating the transportation budget

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FIGURE 3: BREAKOUT OF TOTAL LIFT

TOTAL LIFT: ARMY DSA/GSA

EXCLUDING AMMO, ASSEMBLED

A/C

BREAKOUT

MAJOR - ARMY   SPECIAL - DSA/GSA

TS = IL, Sea: Air   Sea: Air

External* LCA - FB** Internal* LCA - FB**

Remainder - Secondary Army, Other DSA/LSA

Sea : Air

Internal* "Residue" **
                               TCMD Cards

* Type of forecast

** "System" for summing particular lift portion

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for the Army. The short range forecast on the other hand is used by
MSC/MAC to schedule ships/planes/crews to some degree. The actual lift
of cargo is a result of the generation of available freightage. The
short range forecast may not be precise due to external factors such as
backordered items, transportation delays from depots to terminals, pro-
duction delays and over runs from one month to another.

The long range forecast is submitted at two times. The first forecast
submitted by the XCOM and USAILCOM is a preliminary estimate of the next
fiscal year, one year removed. This is due at LCA in May. The final XCOM
long range forecast is due at LCA in November. These forecasts are then
forwarded to MSC/MAC by July and February respectively. See Figure 4
for breakout.

The short range forecast which is for the next 90 days is submitted
every month. Presently, MAC only requires a 30 day forecast, 90 days
before the operating month. However, because the forecast is automated
and nothing is lost by submitting a 90 day forecast, a 90 day forecast
should be made to MAC also. See Figure 4 for breakout.

The XCOMs and USAILCOM submit the short range forecast by the 20th
of the month, two months before the operating month. LCA has to get the
forecast to MSC/MAC by the 10th of the month prior to the operating month.
This means that LCA has approximately 20 days to get the forecast finalized.

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FIGURE 4

TIMING OF FORECASTS

LONG RANGE

BY	ORGANIZATION	FORECAST FOR	TO
25 MAY (FY 76)	XCOM/USAILCOM	JULY-JUNE (FY 78)	LCA
25 NOV (FY 77)	XCOM/USAILCOM	"	LCA
1 JUL (FY 77)	LCA	"	MSC/MAC
1 FEB (FY 77)	LCA	"	MSC/MAC

SHORT RANGE

BY	ORGANIZATION	FORECAST FOR	TO
20 APR	XCOM/USAILCOM	JUN-JUL-AUG	LCA
10 MAY	LCA	JUN-JUL-AUG	MSC/MAC

CHAPTER III

EXTERNAL FORECASTS

3.1 Data Sources

For the purpose of this work an external forecast is a forecast which
is done outside of LCA. There are seven external forecasts - one by each
of the 6 XCOMs and one by USAILCOM.

The XCOM external forecast is based upon information found in the
Category II, Distribution Level, Major Item Distribution Plan, MIDP.
The Category II MIDP covers: the planned distribution/redistribution
of equipment items currently in the Army Inventory and those equipment
items scheduled to come into the Army Inventory in the buy and new budget
years. This form of the MIDP is updated semi-annually for the following
equipments:

> a. All equipment in the PEMA Item Baseline List, PIBL. The
> PIBL includes all items used to derive the PEMA budget.
>
> b. Other items as directed by the Department of the Army.
>
> c. Additional items required by DARCOM or XCOM [4].

The Distribution Level MIDP is prepared by standard study number,
SSN. A SSN defines a class of items which are similar in nature but which
have different line item numbers, LIN. For example, a cargo truck with
a winch has a different LIN than a cargo truck without a winch, but both
have the same SSN.

The MIDP is produced semi-annually with requirements by month for
the remaining portion of the present year and by quarter thereafter. The
destination of the requirements are by several areas for the most part.
For example, the destination may be Europe rather than Germany; however,
there are instances, Korea and Japan, where distribution to countries
may be identified rather than a general area.

The external forecast from USAILCOM is based on the International
Logistics Supply Delivery Plan, ILSDP. The ILSDP is updated quarterly
and is for the current fiscal year plus two years. The requirements are
broken out into quarters in the ILSDP. Since the Army submits a monthly

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over-ocean forecast the quarterly figures will have to be broken down to monthly figures. The proposed forecasting scheme projects the same monthly forecast for such 90 day periods. Thus, the quarterly ILSDP forecast will be divided by three to get a monthly forecast.

The ILSDP is developed by the XCOMs for USAILCOM use. USAILCOM does not derive the requirements themselves. However, USAILCOM does receive lift data on IL and they can relate the transportation control number, unique to every shipment, to individual items. Hence, they have a very good method of observing what the actual lift was compared to projections as well as updating projections based on what has transpired in the early part of the quarter.

The ILSDP is by stock number and the country to which it is going is specifically identified. The ILSDP is broken out by the following funded programs: Grant Air (GA), Foreign Military Sales (FMS) and Agency for International Development (AID).

The ILSDP is made up of items which are:

        a. Major, principal, or end items.

        b. Known or potential critical items.

        c. AID requirements for which there is competition with U.S. Forces.

        d. Items required to support other defined items [1].

Major items for the cargo forecast procedure are identified as any item found in the MIDP or ILSDP. If it is found in the MIDP it is for Troop Support TSP, and if it is found in the ILSDP it is for International Logistics, IL. Items in the ILSDP are identified by aid or sales. Since there are requirements by MSC/MAC as well, the identification of items on the ILSDP by these classifications will be carried over to the over-ocean forecast.

The commodity type for TSP is identified from the ALMSA file, NSNMDR, the National Stock Number Master Data Record. Sector 16, segment 04 has the Water Commodity Code given in [4]. USAILCOM has the commodity code available from the lift data which has the commodity of the lift itself.

The TSP weight and cube is found in the Army Master Data File (AMDF), and the IL is again found in the lift data received by USAILCOM.

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3.2 Forecast Submissions

The XCOMs and USAILCOM will submit the same kind of forecast. From the MIDP and ILSDP the items will be identified (SSN is good enough) and the quantity will be determined. The weight and cube of the items are obtained from the AMDF.

The lift data which USAILCOM receives directly from the Transportation Services has weight and cube on it. This data should be used by USAILCOM when available for particular items since it may be more accurate than the AMDF. Although the lift history weight and cube is usually taken from the AMDF, the AMDF is sometimes the last record to be updated and thus the lift history should be at least as good as the AMDF.

The external forecasts will be submitted by MACRO - destinations, i.e., general areas to which cargo go rather than specific countries (some of the general areas are specific countries however). Figure 5 indicates these general areas. Some of these MACRO - destinations are not considered in the MIDP but they are included because the ILSDP covers these areas. Since the ILSDP covers specific countries, USAILCOM will have to do some "lumping" to get the forecasts aligned to the MACRO - destinations.

XCOM and USAILCOM need not be concerned with other aspects of the forecasts; mode of transportations, commodity and type package. These are taken care of by LCA. The mode and commodity forecasts for sea lift will be taken care of by LCA in the lift array (see Section 2.4) and the type of package will be taken care of separately (see Section 4.4).

The XCOM and USAILCOM forecasts will simply be the weight and cube by the smallest breakdown possible from the MIDP, and, by country for ILSDP. From these general forecasts more specific forecasts will be made based on the past lift history and a Kalman Filter forecasting algorithm (see Section 4.2 for details).

Under the present circumstances the XCOM and USAILCOM forecasts will not be a routine achievement. The MIDP and ILSDP are produced in hard copy. The AMDF is a magnetic tape file. The lift data is in card form as it arrives at USAILCOM and is converted to tape so USAILCOM has a little more freedom for where or how to get the weight/cube match ups. Either

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FIGURE 5

MACRO - DESTINATIONS

North Atlantic

Panama

Caribbean

Central America

South America, West

South America, East

Azores

British Isles

North Europe

Mediterranean, West

Mediterranean, East

Africa, West

Africa, South and East

Persian Gulf

Burma, India

China Sea

Philippines

Central Pacific

Korea, Japan

Australia, New Zealand, Coral Sea

South Pacific

Hawaii

North Pacific

Antarctica

way, manual comparison of the items stock number will have to be made to find the weight and cube.

This will only have to be done on a semi-annual basis at the XCOMs and a quarterly basis at USAILCOM. However, there should be monthly updates as to the significant troop movement or rescheduled international logistics deliveries. The next section will explain which organizations should be making the updates.

There is a study underway now to automate the MIDP. There have been plans to automate the ILSDP also but for the present they have been postponed. When and if these plans are automated, the procedure described here will be made much more ameanable to everyone concerned.

At this time it should be pointed out that the appropriate XCOM will provide forecasts for ammunition and assembled aircraft. Nothing has been mentioned up to now about this because the present techniques of forecasting these requirements are adequate. Ammunition transportation is accomplished by a special more restrictive reporting system and is moved on dedicated ships. The assembled aircraft are forecast based on semi-annual meetings where plans for aircraft movement are developed for essentially the same time period as the MIDP. These plans are pretty well followed in the new time frame for the distribution of aircraft.

3.3 Coordination of Information

The forecasted weight and cube are to be submitted as semi-annual reports from XCOM and quarterly reports from USAILCOM to LCA. The XCOM reports will originate in Materiel Management Branches (item managers). The item managers will do the actual forecast computation. They will send the forecast to the Transportation Branch where all the forecasts will be consolidated to one forecast from the XCOM for the different MACRO channels. After the consolidation effort by Transportation, the forecast will be forwarded to LCA.

Since the XCOM forecasts are semi-annual forecasts, there may be updates needed from month to month within a forecast. The first one to know about changes in requirements will usually be the item manager. The

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item manager should get in contact with Transportation and let them know that a change is expected for the forecast period - this need not be a formal notification, it may be a telephone call to say when the change is expected to occur and which MACRO channel would be effected. Transportation will coordinate the expected changes per forecast per month and forward them to LCA on the same timing schedule as the regular monthly forecast.

USAILCOM is slightly different in that they do not have item managers. However, there are persons aware of delayed procurement and overhaul or rebuild projects, for example, the Program Operations Directorate. Based on this knowledge, information should be sent to the Systems Development Directorate which will act as the coordinator for USAILCOM, similar to the Transportation Branch at XCOM. The Systems Development Directorate will consolidate the initial forecast and forward it to LCA as well as coordinate updated information within a forecast period (quarter) and forward that information to LCA.

Thus, there will be two groups involved with any forecast - the division which actually derives the forecast and the division which consolidates the forecasts for various items/countries and acts as coordinator with LCA (next chapter) for when these forecasts should be forwarded to LCA.

CHAPTER IV

ROLE OF THE LOGISTICS CONTROL ACTIVITY

4.1 Data Sources

LCA is responsible for internally generated forecasts of sea and air lift associated with "special" DSA/GSA items and with residue cargo, which mainly consists of secondary items for Army and DSA/GSA. These internal forecasts are obtained from updates of the average lift values stored in the arrays. In actuality the LCA computer programs shall update all 8 arrays shown in Figure 2, since the average lift values in the major Army arrays are needed to modify the external forecasts of these same lift portions. This modification is accomplished by means of a bridging table (section 4.3.1) stored in the computer which breaks out into lift channels the external forecasts submitted by general overseas areas.

A monitor stationed at LCA is responsible for overseeing both internal and external forecasts and making manual adjustments. His attributes and duties are outlined in section 4.5.

The direct source of data is the monthly cargo movements (short tons or measurement tons) by channel as compiled by the LCA feedback system for the 8 types of lift described in section 2.4. The TCMD cards submitted by the air and surface lift activities covering moved cargo for a given month, in conjunction with the requisitions in the Logistics Intelligence File associated with given transportation control numbers, provide the primary data. The general methodology and logical changes to LCA programs to provide the necessary breakouts are described in Chapter II and Appendix A. The other data necessary are the stored elements - average lift L and the two factors-WGT, K - in the 8 arrays, arranged by origin, destination and commodity.

For the LCA manipulation of the external forecasts, an additional data set is required - the external forecasts themselves. As described in Chapter III, total weight and cube values by general areas (the term used in section 3.2 is "macro-channel") are projected monthly by the

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XCOMS and USAILCOM for 1,2, and 3 month lead times.

The monitor should continually be receiving data from outside sources. Late changes to external forecasts from the Commands and shifts in policy which impact on specific lift channel requirements necessitate manual intervention with stored computer values.

4.2   Internal Forecasts

These forecasts for portions of the total lift are generated internally from information stored in the average lift arrays, ALAs. In terms of array codes, internal forecasts are made for lift associated with 3,4,4A,4A.

4.2.1   Updating Average Lift Arrays

Let $M(n)$ be the actual movement in month n associated with a cell in a particular lift array, i.e. for some origin, destination and commodity combination. $M(n)$ is obtained in short tons (for air arrays) or measurement tons (for sea arrays) . Then two equations describe how to update the WGT and L elements of the array cells.

$$WGT\ (n)\ = \frac{1 + k\ \cdot\ WGT\ (n-1)}{1 + k\ \cdot\ WGT\ (n-1) + k} \tag{4.1}$$

$$L(n) = \quad L(n-1) + WGT(n)\ [M(n) - L\ (n-1)] \tag{4.2}$$
$$= \quad L(n-1)\ \cdot\ [1-WGT(n)]\ \ + WGT(n)\ \cdot\ M(n) \tag{4.2'}$$

where

$L(n) = $ estimate of average monthly lift after month M

sea : measurement tons   air: short tons

$WGT(n) = $ a variable weight factor applied to the most recent movement $M(n)$

$k \quad = $ a parameter to be asigned to the array cell in a manner described below

Note that the first form (4.2) of the equation for $L(n)$ emphasizes that the previous estimate $L(n-1)$ is adjusted by an amount proportional to the error term $E(n) = M(n) - L(n-1)$. Equation (4.2') indicates that the algorithm is akin to exponential smoothing, with a variable smoothing constant $WGT(n)$.

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EXAMPLE: UPDATING INTERNAL FORECASTS

CURRENT ESTIMATE OF LIFT (IN MTONS) -

SECONDARY ARMY - DSA/GSA, TO NORTH EUROPE FROM

EAST COAST BY SEA = $L(n-1)$ = 2000

CURRENT WEIGHT FACT = $WGT(n-1)$ = .3

k = 3 SINCE EVERY MONTH HAS SOME TONNAGE

CURRENT MONTHS MOVEMENT $M(n)$ = 4000

$$WGT(n) = \frac{1 + 3 \,(.3)}{1 + 3 \,(.3) + 3} = .388$$

NEW ESTIMATE OF LIFT

$L(n)$ = 2000 + .388 (4000-2000)

= 2776

= FORECAST FOR UPCOMING MONTH

4.2.2 Forecasting and Feedback

Having obtained L(n) , the **forecasted lift for any month** n + ℓ
after any month (n) is:

$$\hat{L}(n+\ell) = L(n) \qquad \text{for } \ell = 1,2,3 \qquad\qquad (4.3)$$

Equation (4.3) indicates the assumption that the best estimate for a
month , 30, 60, or 90 days in the future, is an average based on some
weighting of all past history up to the present. We have lacked
historical data and this has precluded making any assumptions on
seasonality or trends on individual channels in specific arrays. Ex-
perience of 12-24 months under the proposed system would be needed to
detect seasonal changes; IRO could do post analysis of the movement
over major channels and devise some monitoring rules for seasonal ad-
justments if seasonality exists. Short term trends are hard to predict,
but the WGT and k values are such (see below) that the algorithm reacts
quickly. Long term trends are handled by monitor modification of aver-
ages and WGT, k parameters.

The feedback property for these internal forecasts is inherent
in equation (4.2) . If one over-forecasts (under-forecasts), then
E(n) is negative (positive) and one decreases (increases) the estimate
of L. The WGT(n) describes one's current belief in the importance of
the most recent forecast error.

There is no need to transmit, using the LCA feedback system, any
actual lift for these internal portions (e.g. secondary items) back to
the individual XCOMS, since the feedback data does not influence their
forecasts for major item movements.

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4.2.3 The k-parameter

Observe in equation 4.1 that if k is very small, WGT is close to 1, indicating that the most recent monthly movement M(n) strongly influences the estimate L(n). If k is very high, then WGT continually decreases and after a substantial number of updates, the long term average of L is more important than the latest value of M.

IRO has been quite successful in employing algorithms such as (4.1), (4.2) with this "k-factor" for forecasting demands and returns. Based on experience in determining k factors which depend upon demand frequency, we have constructed a table of k-factors (see Appendix C for rationale) for overocean forecasts of tonnage based on the "activity" of a channel.

Activity Level									k	Equivalent moving average
1		> 9	months	of	year	have	no	lift	2	2.7 mo.
2	6+	- 9	"	" "	"	"	"	3.5	3.3 mo.
3	3+	- 6	"	" "	"	"	"	4.5	3.7 mo.
4	1+	- 3	"	" "	"	"	"	3.7	3.4 mo.
5		0	"	" "	"	"	"	3	3.1 mo.

The values for equivalent moving average indicate that most of the L value is attributable to the most recent 3 months; although constant growth trends cannot be tracked exactly, the algorithm will reflect much of the increase in 3 months.

k values can be assigned to channels (origin, destination combinations) initially by looking at previous monthly reports of lift for about a year. After some experience forecasting under this new scheme, analysis can determine if k's should be raised or lowered on channels.

The monitor can also manually adjust the WGT and k values when there are major chronic shifts in lift over channels (see section 4.5).

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4.3 External Forecasts

LCA is to utilize a bridging table (see below) and a computer sub-routine to modify the external forecasts. As discussed in Chapter III the XCOMS determine major item movement schedules by month by macro-destination and determine the CONUS macro-origins (East, West, Gulf, Northwest); for each macro channel, the number of each major items is multiplied by its weight and cube; the summed weight (short tons) and summed cube (measurement tons) are submitted monthly to LCA. LCA has to sum over all XCOMS the weight and cubes by macro-channel.

4.3.1 Use of Bridging Table

Figure 6 shows which surface traffic areas and which currently operating air ports are associated with given macro origins and macro-destinations. The macro destination code is the first digit in the MILSTAMP water port identifier code. The table is not finalized; transportation specialists will complete the MAC column and perhaps compress the macro and micro destinations. The table is to be stored in the computer and used for combining cellular L values of the ALA's. An example follows the general procedure below.

FIGURE 6

EXTERNAL FORECASTS - BRIDGING TABLE

MACRO ORIGIN	MSC TRAFFIC AREA	MAC ACTIVE POE'S
i EAST COAST	1	CNS, DOV, WRI
ii GULF COAST	2	COF
iii CALIF COAST	3	SBD, SUU
iv NW COAST	4	TCM

MACRO DESTINATION	MSC	MAC (EXAMPLES)
A NORTH ATL	5,6,7,8,9,42	
B PANAMA	11	
C CARIBBEAN	12,13,14,15,16	BDA, GBI
D CENT. AMER.	10	
E SOUTH AMER, WEST	44	
F SOUTH AMER, EAST	45	BUE, ASU, RIO
G AZORES	46	
H BRIT ISLES	18	
J NORTH EUROPE	17	
K MEDIT, WEST	19	
L MEDIT, EAST	20,43	
M AFRICA, WEST	21	
N AFRICA, S&E	22	
P PERSIAN GULF	23	

FIGURE 6 (CONT)

MACRO DESTINATION	MSC	MAC
Q BURMA, INDIA	24	
R CHINA SEA	30,33,40,48,49	
S PHILIPPINES	32	
T CENTRAL PACIFIC	28,29,38	
U KOREA, JAPAN	31,50,51,52	
V AUST, N.Z., CORAL SEA	34	
W SOUTH PACIFIC	49	
X HAWAII	27	
Y NORTH PAC & N.W. ARCTIC	25,26,37	
Z ANTARCTICA	47	

MACRO CHANNEL = MACRO ORIGIN X MACRO DEST.

MICRO CHANNEL = INDIVIDUAL MSC OR MAC CHANNELS CONSTITUTING A MACRO CHANNEL;
BREAKOUT OF LIFT ARRAYS

BRIDGING TABLE TO BE STORED IN COMPUTER

EXAMPLE: BRIDGING FOR FACTORS

PROJECTED TOTAL WEIGHT & CUBE FOR MONTH n+3 FOR MAJOR ITEMS, IL,

FROM GULF COAST TO CARIBBEAN

$W(mc, n+3) = 500$ SHORT TONS

$C(mc, n+3) = 1000$ MEASUREMENT TONS

CURRENT LIFT AVERAGES FOR MICRO CHANNELS IN MACRO CHANNEL

	LSEA ($\cdot$, n)	LAIR ($\cdot$, n)
	100 MT	50 ST
• 2-12 GULF-BERMUDA		
• 2-13 GULF-ANTILLES	200	100
• 2-14 GULF - P. RICO	-	-
• 2-15 GULF - CARIBBEAN	300	50
• 2-16 GULF - BAHAMAS	500	-
	1100 LSEA(mc,n)	1100 LAIR(mc,n) 200

$$B(mc,n+3) = \frac{1000}{1100 + 200 \times \frac{1000}{500}} = \frac{2}{3}$$

TO FORECAST FOR MONTH n+3 ALL MICRO CHANNEL VALUES ARE REDUCED BY FACTOR 2/3

Procedure for bridging for factors:

(1) XCOMs submit weight and cube factors over MACRO channel, mc. Let total over all XCOMs of Army-Major-TSP be W(mc), C(mc).

(2) LCA sums avg lift in MTons over sea MICRO channels in ALA 1 associated with MACRO channel mc. Call this LSEA(mc). Similarly ALA 1A obtains LAIR(mc) in Sh. tons.

(3) The sea forecast for MSC channel ij

$$\widehat{FSEA}\ (ij) = B(mc) \cdot LSEA(ij) \qquad (4.4)$$

The air forecast for MAC channel k ℓ

$$\widehat{FAIR}\ (k\ell) = B(mc) \cdot LAIR(k\ell) \qquad (4.5)$$

where
$$B(mc) = \frac{C\ (mc)}{LSEA(mc)\ +\ LAIR(mc)\ \times\ \frac{C(mc)}{W(mc)}} \qquad (4.6)$$

The rational for Equation (4.6) is found in Appendix D.

(4) Repeat 1-3 for USAILCOM submissions of IL weight and cube by MACRO channels. Use ALA 2 and ALA 2A.

For special, freeze and chill commodities, there are no cells in the air arrays since everything is General Air Cargo, nor are there any weight submissions W(MC) from the XCOMs. Hence for surface forecasts for these commodities the bridging factor

$$B(mc) = \frac{C\ (mc)}{LSEA(mc)} \qquad (4.7)$$

4.3.2 Forecasting and Feedback

When the external submissions C, W are made in month n for month n + ℓ, $\ell = 1,2,3$ and the lift variables LSEA, LAIR are for current values L(n), then the forecasts FSEA, FAIR are for month n + ℓ. In a consistent notation

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$$\widehat{FSEA} \ (ij, n+\ell) \quad = \quad B(mc, n+\ell) \quad \cdot \quad LSEA(ij,n) \tag{4.8}$$

where

$$B(mc, n+\ell) \quad = \quad \frac{C(mc, \ n+\ell)}{LSEA(mc,n) \ + \ LAIR \ (mc,n) \ \times \ \frac{C(mc, n+\ell)}{W(mc, n+\ell)}} \tag{4.9}$$

The L values are updated for arrays 1,2,1A,2A as in section 4.2.

The LCA program should be delayed as long as possible until late changing weight and cube totals from the XCOMS are "firm."

Again as with the internal forecasts there is feedback inherent in the updating algorithms for L. Also the monthly movement M(n) for major items (array codes 1,1A) will be identified by NICP and MAC, MSC channels and sent by the LCA feedback system to the XCOMS. This will present an opportunity to assess the value of the MIDP as a document of projections. No reaction should be made (in terms of modifying forecasts) until enough feedback data is collected to detect bias or time lags in the MIDP based forecasts.

4.4 Type Pack Factors

When reporting surface movement projections to the Military Sealift Command, it is required to designate the portions of each channel forecast that will be moved by SEAVAN (SV), MILVAN(MV) and BREAKBULK (BB). Since the XCOMS have no particular expertise in allocating the movement except from past experience, it is more reasonable for LCA to formulate average factors based on past percentages for total surface movement across all XCOMS. When the total surface lift is broken out for designation to the various ALA's, the type pack code on the TCMD will be queried to determine if the movement was SV, MV, or BB. A subroutine will be called to utilize the most recent 3 months of lift - by MSC destination 5 through 48 and by array codes 1+2, 3 and 4 - to obtain and store type pack percentage factors in the format of Figure 7.

The final sea forecast (internal or external after other adjustments) for a given destination and for item type (major TSP + IL, special DSA/GSA, or RESIDUE) is multiplied by the set of 3 percentages to yield 3 forecasts for BB, SV, MV.

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FIGURE 7

TYPE PACK FACTOR

MICRO(MSC) DESTINATION	MAJOR (ALA 1 + 2)			SPECIAL (ALA 3)			RESIDUE (ALA 4)		
	BB	SV	MV	BB	SV	MV	BB	SV	MV
5	$f_{5,BB}$	$f_{5,SV}$	$f_{5,MV}$	$g_{5,BB}$	$g_{5,SV}$	$g_{5,MV}$	$h_{5,BB}$	$h_{5,SV}$	$h_{5,MV}$
. . . . .									
48	$f_{48,BB}$	$f_{48,SV}$	$f_{48,MV}$	$g_{48,BB}$	$g_{48,SV}$	$g_{48,MV}$	$h_{48,MV}$	$h_{48,SV}$	$h_{48,MV}$

FACTOR $f_{5,BB} = \dfrac{3 \text{ MO. AVG OF MAJOR} \quad \text{BB LIFT TO DESTINATION 5}}{3 \text{ MO. AVG OF MAJOR BB + SV + MV LIFT TO DEST 5}}$

MULTIPLY FINAL SEA FORECASTS BY APPROPRIATE BB, SV, MV FACTORS

4.5 The Monitor

The monitoring aspect of the forecast system is most important. Since the transportation service ultimately react on a daily basis to cargo arrivals at POE's, there is a built-in limitation to the impact of a monthly automated forecast; hence, it is important that up to date manual adjustments be made at LCA for late "phone-ins" from the XCOMS, late-breaking troop movements, policy changes, or implementation of contingency plans.

Attributes

a. A montor should be familiar with forecast techniques and what might be expected statistically - when a run of bad forecasts is significant.

b. He should have contacts at the XCOMS, USALLCOM to receive late changes and to query on "bad" external forecasts. Contacts at MAC, MSC, MTMC are needed to change forecasts already sent out.

c. The monitor needs knowledge of the computer system and what the program do. He must make or instruct to make manual overrides to change channel forecasts or parameters. The details of the man/machine interface can be resolved later with IRO assistance.

Duties

a. Adjust external forecasts for late changes: before the LCA run, this would involve altering weight and cube totals on input cards. Manual adjustments after the computer run would be percentage changes.

b. Examine internal forecasts for "reasonableness": this involves several things - extra information, trends in actual movement that have not been tracked by the automated forecasts.

c. Make parameter changes in stored arrays under chronic long term shifts in channel activity: this is discussed below.

d. Override channels affected by contingency plans; DARCOM is responsible for providing contingent logistical data to XCOM transportation officer. Each plan is different but pre-positioned requisitions give indication of distribution on a time phased basis.

e. Modify the bridging table for adding or deleting channels.

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Chronic Shifts in Channel Activity

If the monitor has advance information that a channel's activity is going to "permanently change" and thus the stored lift averages will become outmoded, he must make some manual changes to computer outputs and subsequently to computer parameters. The monitor will manually adjust the computer generated forecasts by the projected percentage change, but will not adjust stored L, WGT, or k values as long as delayed monthly movements under the old policy are arriving in the computer. As soon as the first month of movement $M(n)$ under the new policy arrives in the computer, the monitor may then adjust stored values and let the computer take over: the monitor adjusts the old L $(n-1)$ value by the projected percentage change and changes the activity level (and hence k) and WGT as shown in Figure 8.

FIGURE 8

TABLE 5.3: CHANGE IN PARAMETERS WITH CHANNEL ACTIVITY

% CHANGE IN CHANNEL TONS	IF INCREASE		IF DECREASE	
	WGT	ACT LEVEL	WGT	ACT LEVEL
0-20%	NO CHANGE	NO CHANGE	NO CHANGE	NO CHANGE
20-40	.5	NC	.6	NC
40-60	.7	NC	.8	LOWER BY 1
60-80	.8	RAISE BY 1	.9	LOWER BY 2
80-100	1.0	RAISE BY 1	1.0	LOWER BY 3
100-200	1.0	RAISE BY 2		
200-300	1.0	RAISE BY 3		

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CHAPTER V

ALTERNATIVE FORECASTING SYSTEMS

5.1 General Considerations

The objectives of this project were to resolve basically two questions: 1) who should be making the forecast and 2) what data base should they be using to make the forecast. In the preceding chapters we have presented a methodology which we consider to be the best answer to these two questions. There are many answers to these two questions and no objective analysis was done to find the "best" answer to these questions because of both time and data constraints. Thus, the answers proposed are subjective and reasonable but may indeed not be the "best" answer. The operational analysis has shown certain aspects of the answer to the questions are not possible. The procedure presented does appear to be the most desirable under the present circumstances. The next two sections discuss two other alternatives with reasons why they were considered and why they were rejected.

5.2 Standardization of Present Procedures

The present procedures are anything but standard. However, for the most part the XCOMs forecast the major and secondary parts. They use different data bases and various forecast techniques. This alternative concerns standardizing the data bases and techniques used to forecast over-ocean requirements.

The major and secondary items would be broken out separately. The major item forecasts would still use the MIDP and ILSDP as in the proposed procedure. However, the secondary items would be forecasted based on the Requirements Determination and Estimation System (RDES). This is the basic requirements computation module of the Commodity Command Standard System (CCSS) upon which the budget requirements are projected as well as the actual procurement quantities. Using this base for secondary items is advantageous because it is the same base on which budgets are made and should be more accurate than the proposed secondary forecast. The RDES has taken account of troop buildup and withdrawals; thus, less reliability

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on the coordination of Material Management/Transportation/LCA monitor will be required. This also means it is not as critical for the LCA monitor to react to up-to-date information as the proposed procedure.

The remainder of the forecast would be an LCA requirement as it is the proposed system. That is, they would be responsible for the DSA/GSA portion and for breaking up the XCOM/USAILCOM forecasts by commodity/ mode/etc.

The accuracy aspect of the forecast can almost be neglected since the XCOM'stotal forecast is only about 20% of the total forecast submitted by LCA for the sea mode forecast. Also, starting January 1, 1977, the RDES will not break out troop support and supply support arrangement (IL) requirements. This is needed since MSC/MAC require the forecast broken down into troop support and IL. This would require another breakout by LCA from a total figure much like the lift array.

The RDES does not necessarily have a monthly or quarterly breakout of requirements. Instead the requirements are broken out to cover the safety level, the leadtime, the reorder quantity, mobilization requirements, etc. Therefore, even this accuracy would be diluted because of the mismatch of the requirements schedule with regard to months.

The use of the RDES would require some programming effort by the Automated Logistics Management Systems Agency (ALMSA). They do the programming for CCSS and this would be a part of CCSS procedures. ALMSA will get into some programming eventually when or if the MIDP is automated. Hence, this need not be considered a serious concern under the alternative forecasting scheme.

It appears that the more work done by XCOM, i.e., more forecast responsibility, the more work necessary, as far as programming is concerned, by LCA. The RDES requirements are based on different MACRO-channels (areas) than the MIDP; hence, more bridging tables would be needed if the XCOMs do the secondary forecast. This also is not a serious consideration since the major part of the bridging table is already necessary in the proposed procedure and adding a few more areas is not a serious problem. At the same time, none of the revisions will lessen any programming needed to

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be accomplished by LCA. For example, lift arrays will still be needed to provide percentage factors to breakout gross external forecasts.

5.3 LCA Sovereignity

This alternative is the simplest procedure. LCA would do all the forecasting; no direct forecasts would be received from either XCOM or USAILCOM. LCA would base their forecast on total lift history and update internally as in the proposed procedure. This would mean that no bridging tables would be needed and everything - major, secondary, special - would be done the same way. Since the foreast still has to be broken down by mode, program, commodity, destinations and type of package, the lift arrays are still needed. Because there is no XCOM involvement in the initial forecast, the forecast can be delayed so the latest information is available from the transportation coordinator at XCOM and USAILCOM. The transportation coordinator becomes a very important aspect of this forecast process because they must make LCA aware of planned shifts in transportation requirements. This is very important because there is no such information used in the actual forecast, it is simply based on previous lift experience. Along with being the simplest technique, it is also the least accurate.

This forecast does lose something by not being directly related to the XCOM/USAILCOM projections. Therefore, it is absolutely essential that good communications exist between XCOM/USAILCOM transportation divisions and the LCA monitor. The monitor will have to be a very alert, dynamic person to make use of the information received. The information will probably not be in tons; therefore the monitor will have to translate troop movements, delayed production schedules, etc. into tonnage reductions or increases.

Although this forecast is the simplest, it is strictly a lift history forecast with significant movements or non-movements resulting in adjusted forecasts. A big uncertainty is how the reductions/increases affect the tonnage. Only experience on the monitor's part could even begin to answer the question. Therefore, this method could make a "good" forecast quite dependent not only on one organization, LCA, but even quite probably on one individual, the monitor.

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BIBLIOGRAPHY

1   AMCR 795-10, "International Logistics Supply Delivery Plan (ILSDP),"
    27 March 1975.

2   AR 55-30, "Space Requirements and Performance Reports for Transporta-
    tion Documents," 28 May 1976.

3   AR 700-120, "Materiel Distribution Management," 14 March 1974.

4   DoDR 4500.32-R, "Military Standard Transportation and Movement
    Procedures (MILSTAMP)"

5   FM 38-24, "Classes of Supply," March 1976.

6   Griswold, John, "Forecasting Over-Ocean Transportation Requirements,"
    Logistics Studies Office, ALMC, Ft. Lee, VA, Jan 1973.

7   Guerin, U.C., "Volume III: Analysis of 1969 Army Supply Demands in
    Vietnam," Institute for Defense Analyses, August 17, 1970.

8   Logistics Control Activity Operating Procedure, Chapter 19,
    "Over Ocean Feedback Reporting," March 1976.

9   Orr, D.A., "Demand Forecasts Using Process Model and Item Class
    Parameters: Application of Ancillary Variables," USDRC Inventory
    Research Office, IRO-219, April 1976, AD #A026081.

3-8.   TRANSPORTATION CONTROL NUMBER (TCN).   a.   The TCN identifies the
shipment unit and allows it to be controlled as a separate entity from
origin to ultimate consignee.   If a shipment unit is divided into in-
crements or shipped in more than one container (including CONEX), during
the transportation cycle each increment will be identified in the TCN
as a partial or split shipment and documented individually.   Partial
and split shipment codes are prescribed in paragraph K-8. (DoDR 4500-32-R)

b.   The shipping activity will assign a TCN to each shipment unit,
except SEAVANS, during the shipment planning operation.   TCNs for SEAVANs
will be assigned by the clearance authority when clearance is issued.
SEAVANs loaded to less than capacity and loaded with additional cargo at
a subsequent activity prior to sailing as authorized by the Water Terminal
Clearance Activity (WTCA) will be controlled by the original SEAVAN TCN.

c.   TCN construction procedures for MILSTRIP and non-MILSTRIP ship-
ments are in appendix K.

3-9.   TRANSPORTATION CONTROL AND MOVEMENT DOCUMENT (TCMD).   a.   The TCMD
is the basic MILSTAMP document and provides the data necessary to manage
the shipment throughout the transportation cycle.   TCMD formats for punch
cards, manual and electrically transmitted messages (ETM) with instructions
for preparation are in appendix F. (DoDR 4500-32-R)

2-12.   MILITARY TRAFFIC MANAGEMENT COMMAND.   The Military Traffic Manage-
ment Command (MTMC) is responsible for:

a.   Providing CONUS traffic management service to services and
agencies.

b.   Managing DOD common-user water terminal activities in CONUS and
at selected overseas locations.

c.   Operating military water terminals in CONUS.

d.   Establishing CONUS WTCAs and airlift clearance authorities (ACA)
and developing instructions for their operation based on data input/output
criteria prescribed in this regulation.

e. Advising overseas commands and shipper services of anticipated workload surges resulting from political decisions, national disasters, strikes or other local or national regulatory actions.

f. Providing shipment receipt and lift data to an activity (ies) designated by a military service as required.

g. Disseminating information to theater commands regarding SEAVAN tenders for delivery of retrograde cargo to CONUS inland destinations.

2-13. MILITARY SEALIFT COMMAND. The Military Sealift Command (MSC) is responsible for:

a. Providing worldwide ocean transportation for services and agencies as required.

b. Processing ocean carrier claims and evaluating carrier performance.

6.5. CLEARANCE OF RELEASE UNIT (RU) SHIPMENTS. a. Shipping activities requesting clearance for shipments requiring a positive release will obtain an export traffic release (ETR) or similar releasing document from the WTCA. Procedures for requesting an ETR on RU shipments originating in CONUS (including SEAVAN and TGBL SEAVAN shipments) are prescribed in chapter 202, MTMR. Shipments originating overseas and requiring positive release instructions will be cleared as prescribed in theater directives.

b. The WTCA may furnish an ETR to the shipping activity before a firm booking has been accomplished, concurrently with the accomplishment of the booking, or after a firm booking has been accomplished. In any case, the WTCA will transmit an ETR to the shipping activity and furnish a copy of the request and release to the water terminal. On shipments by SEAVAN service (including TGBL SEAVAN shipments) information on the ETR will include the SEAVAN TCN (assigned by the WTCA), POE, POD, size of van ordered and ocean carrier which the shipping activity will use in the SEAVAN TCMD. The POE and POD will be the actual location of loading and discharge (commercial or military as appropriate) and not merely a military port responsible for loading or discharge operations in that geographic area when discharge is at a commercial port.

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6-9. OCEAN CARGO OFFERING AND BOOKING. a. To provide the most efficient management of cargo and overseas delivery schedules, procedures for administration and submission of cargo offerings by the WTCA and booking of cargo by MSC will be coordinated between the MSC area commands and designated representatives of the WTCA.

b. There are several factors to be considered in offering and booking ocean cargo. The primary factor to be considered is the determination of available ocean shipping capability to effect timely and economical delivery of cargo overseas. Factors of consolidation and other economic aspects of ocean transportation may be considered if actions resulting from such considerations will not jeopardize the RDD of the cargo at destination. Other factors to be considered by MSC in selecting ocean shipping capability include:

(1) Best utilization of MSC controlled vessels.

(2) Capability of the ship to meet requirements of the cargo offered by the WTCA.

(3) DOD policy as it relates to use of American flag service and

(4) Equitable distribution of traffic among U.S. flag commercial carriers consistent with Service capability, lift requirements and lowest cost.

c. MSC booking activities will not challenge requirements for container service except when the container-required offering would necessitate the use of foreign flag ships. DOD policy prohibits the use of foreign flag container service if U.S. flag breakbulk ships are available and capable of meeting the requirement. In these cases, cargo will be booked as breakbulk cargo.

d. Upon receipt of information that specific cargo is available for ocean shipment, the WTCA will determine whether cargo will be shipped in containers or by breakbulk. Where cargo is susceptible to movement either in breakbulk or in container service, and delivery can be obtained by either mode, preference will be given to that mode offering the lowest overall cost to the government. After the lowest cost method of shipment has been determined, the WTCA will submit cargo offerings to MSC for booking. To insure cargo is booked to the low cost carrier that can meet the RDD, it is required that all available cargo be offered to MSC on a daily basis.

e. On the basis of the cargo offering, MSC will, within eight working hours, provide the WTCA a booking, an expected booking time or a notice that a tentative date for booking is not available. When booking is made as illustrated in figure 6-1, MSC will assign shipping capability consistent with requirements of the cargo and furnish the WTCA the following basic information:

(1) Name and type of ship (including the voyage number).

(2) Operator and local agent.

(3) Day ship available for loading.

(4) Itinerary of ship including ETA at discharge terminal(s).

(5) Ship's capability to meet specific cargo requirements such as unusual size or heavy lifts.

(6) Description and location of space to be furnished as soon as available but not later than 48 hours prior to day ship is available for loading.

(7) Terms of carriage, i.e., responsibility of ocean carrier for loading or discharge (or both).

(8) Type of agreement (MSC Shipping Contract, berth term, etc.).

At this time the military activity responsible for loading cargo will indicate acceptance of the shipping capability assigned except in those instances where the activity considers valid circumstances or deficiencies exist. In these instances the activity will so advise MSC, and MSC will review the assignment in conjunction with the activity. MSC will make such adjustment as may be necessary to insure the shipping capability provided is responsive to the requirements of the cargo and consistent with the best interest of the Government. When MSC advises that timely and economical lift cannot be obtained for classified shipments and small increments of Class A and B explosives, the offering activity may withdraw the offer provided that airlift service is available to the destination and that authority for diversion has been granted by the Shipper Service. Upon completion of this coordination, MSC will accomplish a firm booking and issue a clearance order.

g. When commercial vessels accept cargo under MSC Shipping Con-
tracts or Shipping/Container Agreements, firm booking depends upon the
carrier tendering acceptable and accessible space for cargo. The
carrier will advise MSC of any space realignment in sufficient time to
permit coordination with the WTCA and acceptance or rejection of the
changes. The WTCA will advise MSC in writing, with appropriate reasons,
if the space is unacceptable and a satisfactory adjustment cannot be
agreed upon with the carrier without additional cost or other disad-
vantage to the government. Otherwise, the WTCA will accept the space as
assigned. Upon acceptance of the assigned space by the WTCA, MSC will
accomplish a firm booking and issue a clearance/shipping order.

SURFACE EXPORT
CLEARANCE OF DOD CARGO

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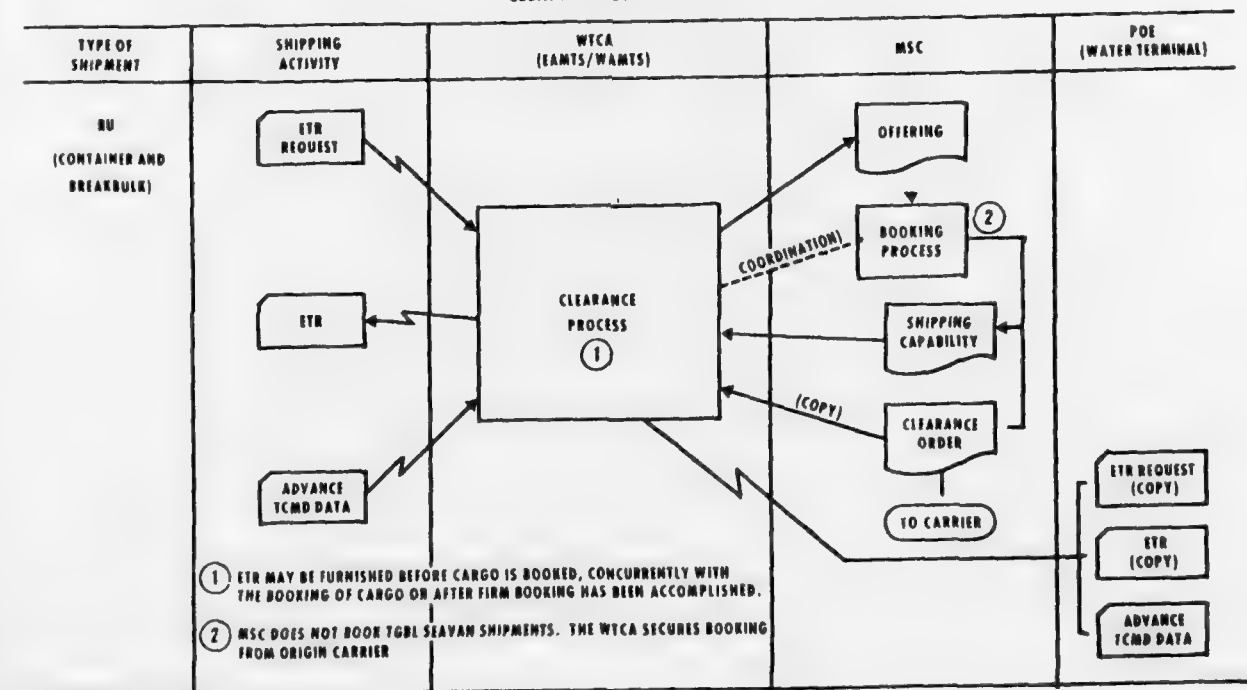
APPENDIX B: BREAKOUT OF MONTHLY LIFT

General Programming Methodology

   The schematic in Figure 2   is a guide to the following procedure.
Starred (*) statements are new logical changes or additions to the LCA
over-ocean feedback reporting program [8], designated "LCA-FB."

A.1 Total air and sea lift for a given month is summed over the ton-
     nages on TCMD cards.

A.2 The LCA-FB is used to "pull out" movement associated with arrays
     1,3,1A, 2A

     (i)   Army - identified by last known RIC

               A or B in first digit

   *(ii)   Major item - identified by Army Materiel Category Code

               2nd position is A through Q, or 5

   (iii)   Troop Support or IL - LCA-FB query of requisition number

    (iv)   Sea Mode - first digit POE is numeric

          Air Mode - first digit POD is alphabetic

    (v)   Commodities -

Chill	Code	100-149
Freeze	Code	150-199
General	Code	500-799
Special	Code	800-899 (excl. 819-20)
GAC	Code	1st position alphabetic

  *   Pull out Ammo (400-489) and Aircraft (900-999) but do not add
      lift to arrays.

A.3 LCA-FB is used to pull out arrays 3,3A.

    (i)   Non-Army, DSA/GSA - identified by last known RIC.

   (ii)   "Special" items - MATCATS (1st position Army Materiel Category Code)

          C,R,S ; also unit weight $>$ 10,000 lbs. or unit
          cube dimension $>$ 35 ft.

  (iii)   Sea or Air Mode - see A.2 iv)

   (iv)   Commodities - see A.2 v)

         Ammo and Aircraft should not be found in this part of
         the logic.

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A.4 Remainder or residue from A.1 (total) should be basically the
lift for Army or DSA/GSA "secondary-like" items (excluding other
Government agencies which should be pulled out). Then monthly
movement for arrays 4, 4A is obtained directly from these remain-
ing TCMD cards without recourse to requisition or weight-cube files.

(i) Troop Support or IL - use TAC on TCMD

(ii) Sea or Air Mode - as in A.2(iv), check the POE and POD
on the TCMD card

(iii) Commodities - Sea is all "General"

Air is all "GAC"

APPENDIX C - Development of k-values
Activity Level of Channels

Orr [9] develops k values for a demand process observed quarterly in terms of the number of demand requisitions per year λ ; a compressed version of the table is given:

λ	1	2	4	6	12
k	2	3.5	4.5	3.7	3

If "events" (a demand requisition, a tonnage lift) are Poisson distributed throughout the year, then the probability of no demand events in a quarter = $e^{-\lambda/4}$ = q . Let

$$Q(n) = \text{Prob (n qtrs with 0 events in them)}$$
$$= \binom{4}{n} q^n (1-q)^{4-n}$$

Since we are concerned with tonnages observed monthly, the k-values are expressed in terms of number of active months/4 mos. rather than active quarters/yr. We can form the following table:

λ	q	Q(0)	(Q(1)	Q(2)	Q(3)	Q(4)	Most likely situation- Out of 4 periods*...
1	.779				.417	.368	3-4 have 0 events
2	.606		.148	.342	.351	.135	2-3 have 0 events
4	.368	.159	.372	.326	.126		1-2 have 0 events
6	.223	.365	.418	.180			0-1 have 0 events
12	.050	.814					no periods have 0 events
							*Quarters or months

APPENDIX D

ASSUMPTIONS OF THE BRIDGING FACTOR B

First note that

$$B \equiv \frac{C}{LSea + LAir \times \frac{C}{W}} = \frac{W}{\frac{W}{C} \times LSea + LAir}$$

Assumption A1: $r = \frac{C}{W}$ is the current best estimate of the cube-weight conversion relationship for items being shipped over the channel.

Now the cube forecast C is composed of a surface portion FSea and an air portion (converted to cube) $r \cdot$ FAir.
Therefore

$$B = \frac{FSea + r \cdot FAir}{LSea + r \cdot LAir} \tag{1}$$

Assumption A2: FSea/LSea = FAir/LAir (2)

or equivalently FSea/FAir = LSea/LAir (3)

Then

$$B = \frac{FSea \left(1 + r \cdot {}^{FAir}/_{Fsea}\right)}{LSea \left(1 + r \cdot {}^{LAir}/_{LSea}\right)} = \frac{FSea}{LSEA} \tag{4}$$

Assumption A3: for micro channels within a macro channel

$$Fsea(ij) \,/\, LSea(ij) = FSea/LSea \tag{5}$$

then $FSea(ij) = B \cdot LSea(ij)$ QED

Similar relations exist for the air forecasts.

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